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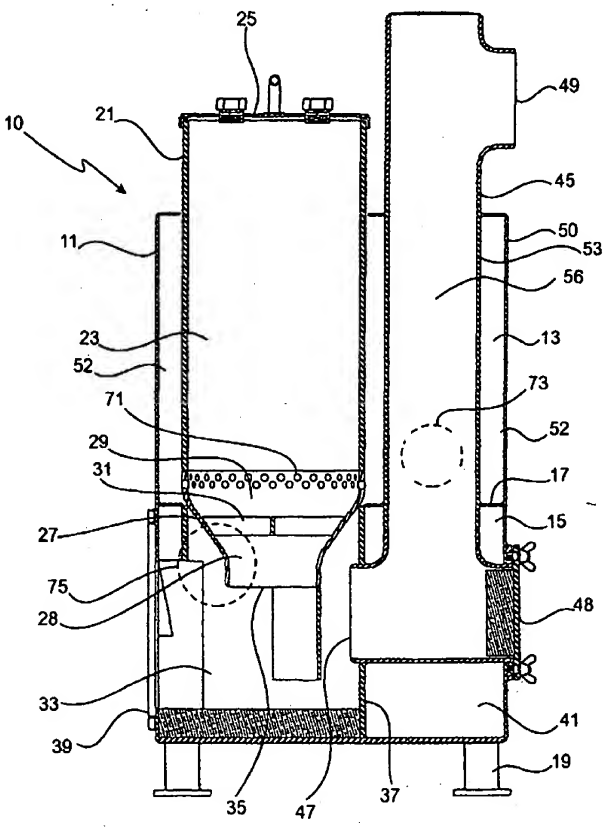
(54) Title: BIOMASS BURNER



(57) Abstract: A burner comprising a fuel reservoir, a primary combustion zone located at the lower end of the fuel reservoir, a secondary combustion zone located underneath the primary combustion zone, a passage providing communication between the primary and secondary combustion zones, a flue for discharging products of combustion from the secondary combustion zone, the primary combustion zone having a peripheral wall incorporating air hole means to provide combustion air to the primary combustion zone, wherein the cross-sectional area of the air hole means is substantially equal to the combined minimum cross-sectional area of the passage and the minimum cross?sectional flow area of the flue.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

"Biomass Burner"

Field of the Invention

This invention relates to a burner.

The invention has been devised particularly, although not exclusively, as a burner for generating heat from combustion of low grade fuels including biomass material such as animal manure and "greenwaste" materials.

Background Art

Australian patent 550050 discloses a burner for solid fuel including biomass material.

The invention according to patent application 550050 describes a burner having a fuel reservoir, a combustion chamber, a grate and a flue. The fuel reservoir is supported above the combustion chamber to open into the combustion chamber at its lower end. Fuel is supported in the grate above the combustion chamber for preheating and/or ignition before entering the combustion chamber. The flue is connected into the combustion chamber to remove combustion products. The fuel reservoir is provided with an air inlet at a location spaced above the grate. The air inlet is typically in the form of a plurality of circumferentially spaced holes arranged around the walls of the fuel reservoir at its lower end.

The present invention relates to improvements to the burner disclosed in the above-mentioned patent.

Disclosure of the Invention

The present invention provides a burner comprising a fuel reservoir, a primary combustion zone located at the lower end of the fuel reservoir, a secondary combustion zone located underneath the primary combustion zone, a passage providing communication between the primary and secondary combustion zones,

a flue for discharging products of combustion from the secondary combustion zone, the primary combustion zone having a peripheral wall incorporating air hole means to provide combustion air to the primary combustion zone, wherein the cross-sectional area of the air hole means is substantially equal to the combined minimum cross-sectional area of the passage and the minimum cross-sectional flow area of the flue.

The air hole means may comprise a plurality of holes disposed circumferentially about the primary combustion zone.

The passage providing communication between the primary and secondary combustion zones preferably tapers inwardly in the direction from the primary combustion zone to the secondary combustion zone in the fashion of a funnel.

It is preferable that the primary combustion zone and the secondary combustion zone be positioned in a manner whereby they are situated close enough for the flames from the primary combustion zone to unite with the flames from the secondary combustion zone.

The flue is preferably provided with an inlet adjacent the secondary combustion zone for removal of the combustion products. The combustion products pass from the secondary combustion zone via the flue inlet through a flue passage and exit the burner via a flue outlet.

Preferably, the minimum cross-sectional flow area of the flue corresponds with the cross-sectional area of the flue inlet. The cross-sectional area of the flue inlet is preferably of approximately equal cross-sectional area to that of the flue passage.

Preferably, a fuel grate is provided at the base of the primary combustion zone.

Preferably, the fuel reservoir has a closable loading entry through which fuel can be loaded into the fuel reservoir.

Fuel loaded into the fuel reservoir rests on the fuel grate. Primary combustion occurs within the primary combustion zone above the fuel grate and is supported by combustion air supplied through the air hole means. As the waste burns, it disintegrates and falls through the grate into the secondary combustion zone as char. The combustion of this char, combined with the volatile gases from the fuel, produces a very high and efficient reaction.

Feedstock which provides the fuel is first preheated in the fuel reservoir. This allows wet feedstock to be utilised. The feedstock is then pyrolyzed in the primary combustion zone above the fuel grate. The resulting pyrolysis gases are then completely oxidised in the secondary combustion zone. Heat is internally recovered from the oxidation step and used to preheat and dry the wet feedstock. Heat which is generated can also be recovered for other purposes such as generation of a hot air stream for space or processing heating.

A heat exchanger may be associated with the flue for extraction of heat energy in the products of combustion. The heat exchanger may comprise a shell-and–tube type heat recuperator having an annular flue passage which forms part of the flue and through which the products of combustion pass. The annular flue passage may be bounded by an inner tube surrounding a central passage through which an air stream can pass to be heated by heat transfer from the products of combustion passing along the annular flue passage. The annular flue passage may also be bounded by an outer tube, spaced from the inner tube, located in an air reservoir containing a body of air. The air in the air reservoir may be heated by heat transfer from the products of combustion passing along the annular flue passage. The air reservoir may surround at least part of the fuel reservoir and upper combustion zone such that heat transfer from the heated air in the reservoir can be used to assist drying of fuel contained in the fuel reservoir. The heated air in the air reservoir may also provide the combustion air which enters the primary combustion zone through the hole means. In this way, the combustion air is preheated.

Moisture from the drying fuel passes from the fuel reservoir and primary combustion zone through the passage to the secondary combustion zone and exits through the flue.

An air heating chamber may be located adjacent the secondary combustion zone, which is the hottest region within the burner. Inlet air may be introduced into the air heating chamber through the central passage of the shell-and-tube recuperator. Alternatively, air may be introduced into the air heating chamber by any other means such as a fan. The heated air may be removed by means of suitable system such as a fan system.

The flue may incorporate a diversion line through which at least some of the products of combustion exiting from the secondary combustion zone can be selectively diverted to the fuel reservoir. This assists the drying process of wet feedstock and so accelerates the combustion process.

Means may be provided for pressurising the secondary combustion zone. This will ensure that volatile pyrolysis gases remain in the secondary combustion zone for a longer period of time so as to be completely oxidised.

The secondary combustion zone may be pressurised by delivering air under pressure into the secondary combustion zone.

A means may be provided for selectively blocking at least part of the flue to assist pressurisation of the secondary combustion zone. The means may comprise a damper incorporated into the flue. The damper may operate under a control means adapted to operate the damper to achieve a predetermined pressure within the secondary combustion chamber once a prescribed operational temperature of the burner has been achieved. The control means may be in the form of a spring loaded means.

As can be seen, the burner may be used to produce heat from the burning of fuel whilst also providing a means for the thermal destruction of the fuel which is particularly advantageous in the case of biomass waste.

Exhaust gases from the burner contain primarily carbon dioxide and water. Accordingly, the exhaust gases are particularly suitable for use in promoting the growth of plant life. To this end, the flue gases may be diverted into a greenhouse environment where plant growth can be promoted through the process of photosynthesis which converts the carbon dioxide into oxygen. Alternatively, the flue exhaust gases may first pass to a slow release tank to allow for the controlled release of exhaust gases to the greenhouse environment.

It is believed that this would be a particularly useful system for reducing greenhouse gas emissions where biomass material is used as feedstock for the burner. Biomass material is neutral in terms of carbon dioxide in that decomposition of biomass material releases carbon dioxide into the atmosphere in any event and thus burning it would not add to the net levels of carbon dioxide production. A particular advantage of the arrangement involving passing the exhaust gases through a greenhouse environment is that the carbon dioxide so produced is converted back into oxygen.

Brief Description of the Drawings

The invention will be better understood by reference to the following description of several specific embodiments thereof as shown in the accompanying drawings in which:

Figure 1 is a schematic view of a burner according to a first embodiment;

Figure 2 is a schematic view of a burner according to a second embodiment; and

Figure 3 is a schematic view of a burner according to a third embodiment.

Best Mode(s) for Carrying Out the Invention

Referring to Figures 1 and 2 of the drawings, there is shown a burner 10 according to the first embodiment. The burner 10 comprises an outer housing 11

defining an upper section 13 and a lower section 15 separated by an internal wall 17. The outer housing 11 is supported on a base 19.

A generally cylindrical body 21 is mounted on the outer housing 11. The body 21 is primarily located in the upper section 13, although the lower end thereof extends to the lower section 15 and the upper end thereof extends beyond the outer housing 11. The body 21 defines a fuel reservoir 23 and incorporates a lid 25 which can be opened to load feedstock into the fuel reservoir 23. The lower end section of the body 21 incorporates an inwardly tapering funnel section 27 which defines a passage 28 providing communication between a primary combustion zone 29 disposed at the lower end of the fuel reservoir above a fuel grate 31 and a secondary combustion zone 33 located in the lower section 15 of the outer housing 11. The tapering section 27 terminates at a port 35 which opens onto the secondary combustion zone 33.

The secondary combustion zone 33 is defined within the lower section 15 between a partition wall 37 therein and an access door 39 though which ash and other debris can be removed from the secondary combustion zone. An air heating chamber 41 is defined in the lower section 15 of the outer housing 11 on the opposed side of the partition wall 37 to the secondary combustion zone 33.

The burner 10 is provided with a flue 45 having a inlet 47 which opens onto the secondary combustion zone 33 and an outlet 49. The products of combustion pass from the secondary combustion zone 33 in the flue inlet 47 through the flue passage 56 to exit via the flue outlet 49.

In the second embodiment shown in Figure 2 (which is not drawn to scale), the flue 45 is incorporated in a shell-and-tube type recuperator 50 designed to extract thermal energy in products of combustion exiting from the secondary combustion zone 33 via the flue 45. The recuperator 50 has an inner tube 51 and an outer tube 53 spaced from the inner tube 51 to define an annular flue passage 55 therebetween which forms part of the flue. As will be noted, the flue passage 56 in the first embodiment is of generally cylindrical shape, whereas the flue passage in the second embodiment is annular.

The annular flue passage 55 communicates with the flue inlet 47 and the flue outlet 49 to allow the products of combustion to exit the burner. The outer tube 53 extends through the upper section 13 of outer housing 11 as shown in the drawings. The inner tube 51 defines a central passage 59 through which air can be delivered to the air heating chamber 41, the central passage 59 having an inlet 63 through which air enters the passage and an outlet 65 opening into the heating chamber 41. Heated air is extracted from the heating chamber 41 by any suitable means (not shown).

The flue 45 is provided with a flue access door 48 through which soot and other debris can be removed from the flue.

The upper section 13 of the outer housing 11 defines an air reservoir 52.

With the recuperator 50, products of combustion exiting the secondary combustion zone 33 via the flue 45 pass in heat exchange relationship with both the inner tube 51 to thereby heat incoming air flowing along passage 59 and the outer tube 53 to thereby heat air accommodated in the air reservoir 52 in the upper section 13.

Heated air contained in the air reservoir 52 surrounds that part of the body 21 accommodated in the upper section 13 and so is in heat exchange relationship therewith to provide heat which assists drying of any wet feedstock introduced into the fuel reservoir 23.

The cylindrical body 21 has a peripheral wall which incorporates a hole means in the form of a plurality of air holes 71 providing communication between the air reservoir 52 and the primary combustion zone 29. The air holes 71 provide combustion air for the primary combustion zone 29. With this arrangement, the combustion air provided to the primary combustion zone 29 from the air reservoir 52 through the air holes 71 is heated by the action of the recuperator 50 as previously explained.

The air reservoir 52 in the upper section 13 is provided with an air inlet opening 73 through which ambient air can enter the air reservoir.

The burner 10 is provided with a heated air outlet 75 for release of heated air.

A particular feature of the burner is that the total flow area of the air holes 71 providing combustion air to the primary combustion zone 29 is substantially equal to the combined flow area of the port 35 in the passage 28 between the upper and lower combustion zones and the minimum flow area of the flue 45. It should be noted that the smallest cross-sectional area of the passage 28 is located at the port 35, and the smallest cross-sectional flow area of the flue 45 is located at the flue inlet opening 47. It has been found that this relationship is particularly important in attaining optimal performance of the burner.

As will be seen in the first embodiment shown in Figure 1, the smallest cross-sectional flow area located at the flue inlet opening 47 is equivalent to the cross-sectional flow area of the flue passage 56. In the embodiment shown in Figure 2, the smallest cross-sectional flow area of the flue 45 is located at the flue inlet opening 47 which is equivalent to the cross-sectional flow area of the annular flue passage 55 although this is not apparent since Figure 2 is not drawn to scale.

The figures show embodiments which have been configured for the generation of hot air. However, the burner may be adapted to use the generated heat in other ways. For example, to heat water the burner may be fitted with water heating coils attached to the outside of the recuperator section.

Referring now to Figure 3 of the drawings, there is shown a further embodiment of the burner. The embodiment shown in Figure 3 operates in a similar fashion to that described in the first embodiment with the addition of several features. One such additional feature is the provision of a diversion line 81 for diverting at least some of the flue gases leaving the secondary combustion chamber 33 along flue 45 to the fuel reservoir 23. With this arrangement, the diverted flue gases are utilised to assist the drying process of wet feedstock and so accelerate the combustion process within the burner.

The burner according to the third embodiment incorporates a further feature involving pressurisation of the secondary combustion zone 33. The pressurisation of the secondary combustion zone is achieved by delivery of air under pressure into the secondary combustion zone by any suitable means such as an electrically operated fan. It has been found that the rate of combustion is accelerated through such pressurisation. The pressurisation ensures that all the volatile pyrolysis gases remain in the secondary combustion chamber for a longer period of time and are completely oxidised. Testing has demonstrated that most of the oxygen supplied to the secondary combustion zone through the pressurised air is utilised in the combustion process.

A damper 85 is incorporated in the flue 45 to assist pressurisation of the secondary combustion zone. The damper 85 operates under a control system arranged to close the damper once the burner 10 has achieved a prescribed operational temperature. This can be achieved by having the damper 85 connected to a spring-loaded mechanism which operates to close the damper at the selected pressure.

In the embodiment shown in Figure 3 of the drawings, the flue 45 is connected to a greenhouse 91 by way of a delivery line 93 which delivers exhaust gases from the burner 10 into the environment within the greenhouse. As the exhaust gases are colourless and odourless and contain primarily carbon dioxide and water, they provide an environment in the greenhouse which is conducive to plant growth. In the greenhouse, the carbon dioxide delivered from the burner 10 is converted into oxygen through the process of photosynthesis, and the converted oxygen is discharged to atmosphere through outlet 97.

It should be appreciated that the scope of the invention is not limited to the scope of the three embodiments described.

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

The Claims Defining the Invention are as Follows

1. A burner comprising a fuel reservoir, a primary combustion zone located at the lower end of the fuel reservoir, a secondary combustion zone located underneath the primary combustion zone, a passage providing communication between the primary and secondary combustion zones, a flue for discharging products of combustion from the secondary combustion zone, the primary combustion zone having a peripheral wall incorporating air hole means to provide combustion air to the primary combustion zone, wherein the cross-sectional area of the air hole means is substantially equal to the combined minimum cross-sectional area of the passage and the minimum cross-sectional flow area of the flue.

2. A burner according to claim 1 wherein air hole means comprises a plurality of holes disposed circumferentially about the primary combustion zone.

3. A burner according to any one of the preceding claims wherein the flue comprises a flue inlet connected to a flue outlet by means of a flue passage.

4. A burner according to claim 3 wherein the minimum cross-sectional flow area of the flue is at the flue inlet.

5. A burner according to claim 3 wherein the minimum cross-sectional flow area of the flue is spaced from the flue inlet.

6. A burner according to any one of the preceding claims wherein the passage providing communication between the primary and secondary combustion zones tapers inwardly in the direction from the primary combustion zone to the secondary combustion zone in the fashion of a funnel.

7. A burner according to any one of the preceding claims wherein the primary combustion zone and the secondary combustion zone are positioned in a manner whereby they are situated close enough for the flames from the

primary combustion zone to unite with the flames from the secondary combustion zone.

8. A burner according to any one of the preceding claims wherein a fuel grate is provided at the base of the primary combustion zone.

9. A burner according to any one of the preceding claims wherein the fuel reservoir has a closable loading entry through which fuel can be loaded into the fuel reservoir.

10. A burner according to any one of the preceding claims wherein a heat exchanger is associated with the flue for extraction of heat energy in the products of combustion.

11. A burner according to claim 10 wherein the heat exchanger comprises a shell-and-tube type heat recuperator having an annular flue passage forming part of the flue and through which combustion products pass.

12. A burner according to claim 11 wherein the annular flue passage is bounded by an inner tube surrounding a central passage through which an air stream can pass to be heated by heat transfer from the products of combustion passing along the annular flue passage.

13. A burner according to claim 12 wherein the annular flue passage is bounded by an outer tube, spaced from the inner tube, located in an air reservoir containing a body of air.

14. A burner according to claim 13 wherein the air reservoir is heated by heat transfer from the products of combustion passing along the annular flue passage.

15. A burner according to claim 13 or claim 14 wherein the air reservoir surrounds at least part of the fuel reservoir and upper combustion zone such that heat

transfer from the heated air in the reservoir can be used to assist drying of fuel contained in the fuel reservoir.

16. A burner according to any one of the preceding claims wherein an air heating chamber is located adjacent the secondary combustion zone.

17. A burner according to claim 16 wherein inlet air is introduced into the air heating chamber through the central passage of the shell-and-tube recuperator.

18. A burner according to any one of the preceding claims wherein the flue incorporates a diversion line through which at least some of the products of combustion exiting from the secondary combustion zone can be selectively diverted to the fuel reservoir.

19. A burner according to any one of the preceding claims wherein a means is provided for pressurising the secondary combustion zone.

20. A burner according to claim 19 wherein the means operates by way of delivering air under pressure to the secondary combustion zone.

21. A burner according to any one of claims 19 or 20 wherein the means operates by way of selectively blocking at least part of the flue.

22. A burner according to claim 21 wherein the selective blocking is effected by way of a damper incorporated into the flue.

23. A burner according to claim 22 wherein the damper operates under a control means to operate the damper to achieve a predetermined pressure within the secondary combustion chamber once a prescribed operational temperature of the burner has been achieved.

24. A burner according to claim 22 or claim 23 wherein the damper operates by means of a spring-loaded mechanism.

25. A burner according to any one of the preceding claims wherein the burner operates in association with a greenhouse environment.

26. A burner according to claim 25 wherein exhaust gases from the burner are diverted to the greenhouse environment from the flue.

27. A burner substantially as herein described with reference to the accompanying drawings.

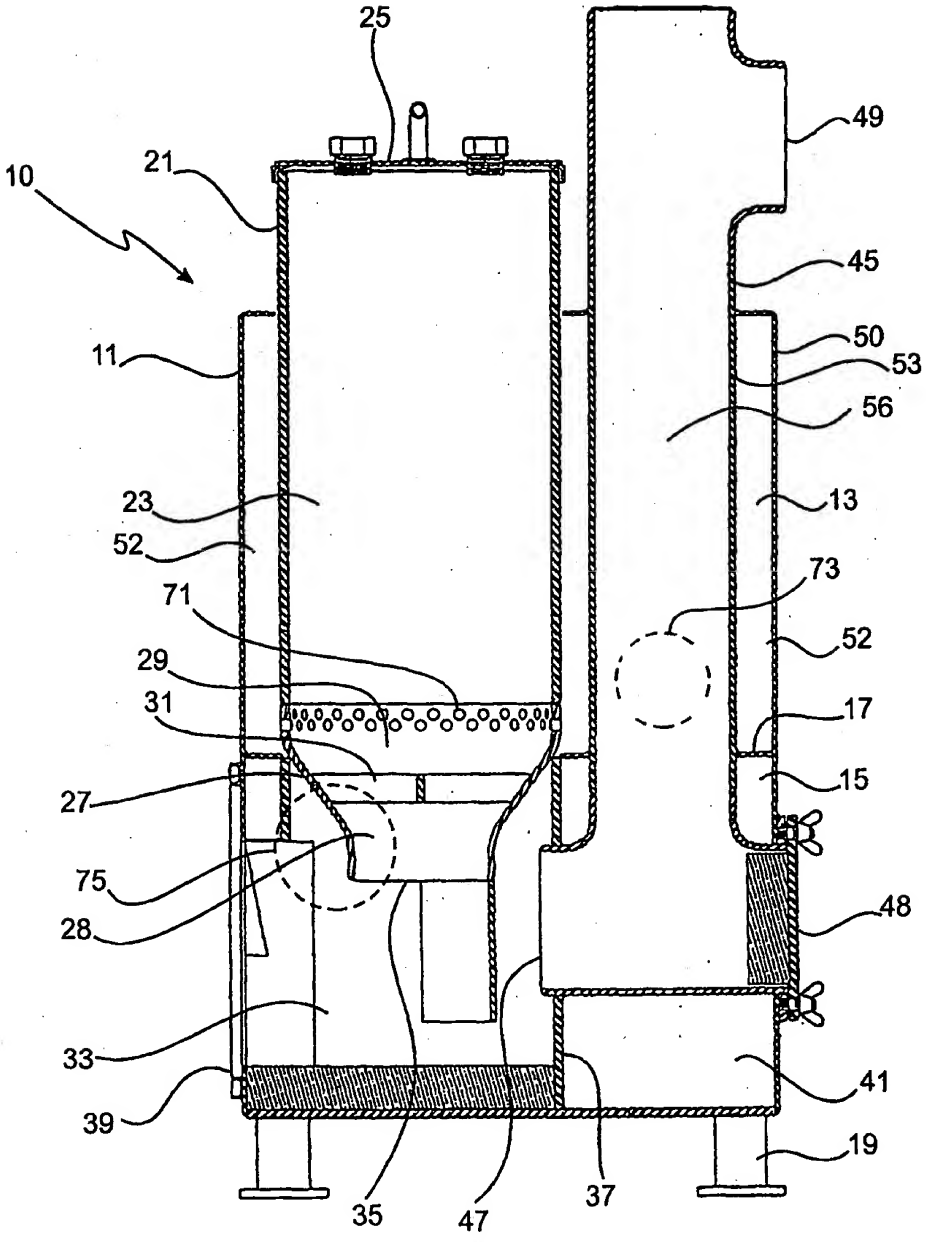
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Fig. 1.

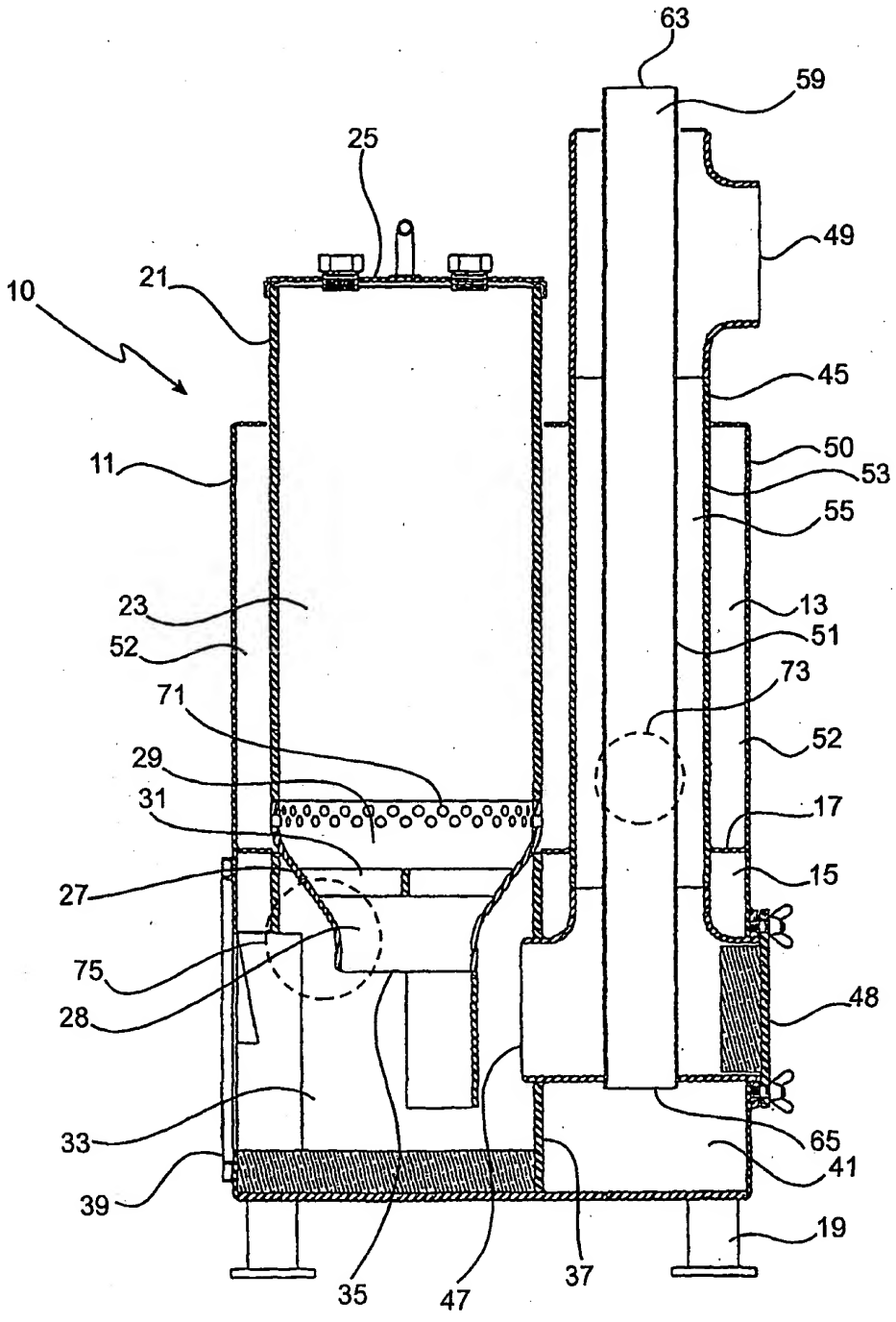
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Fig. 2

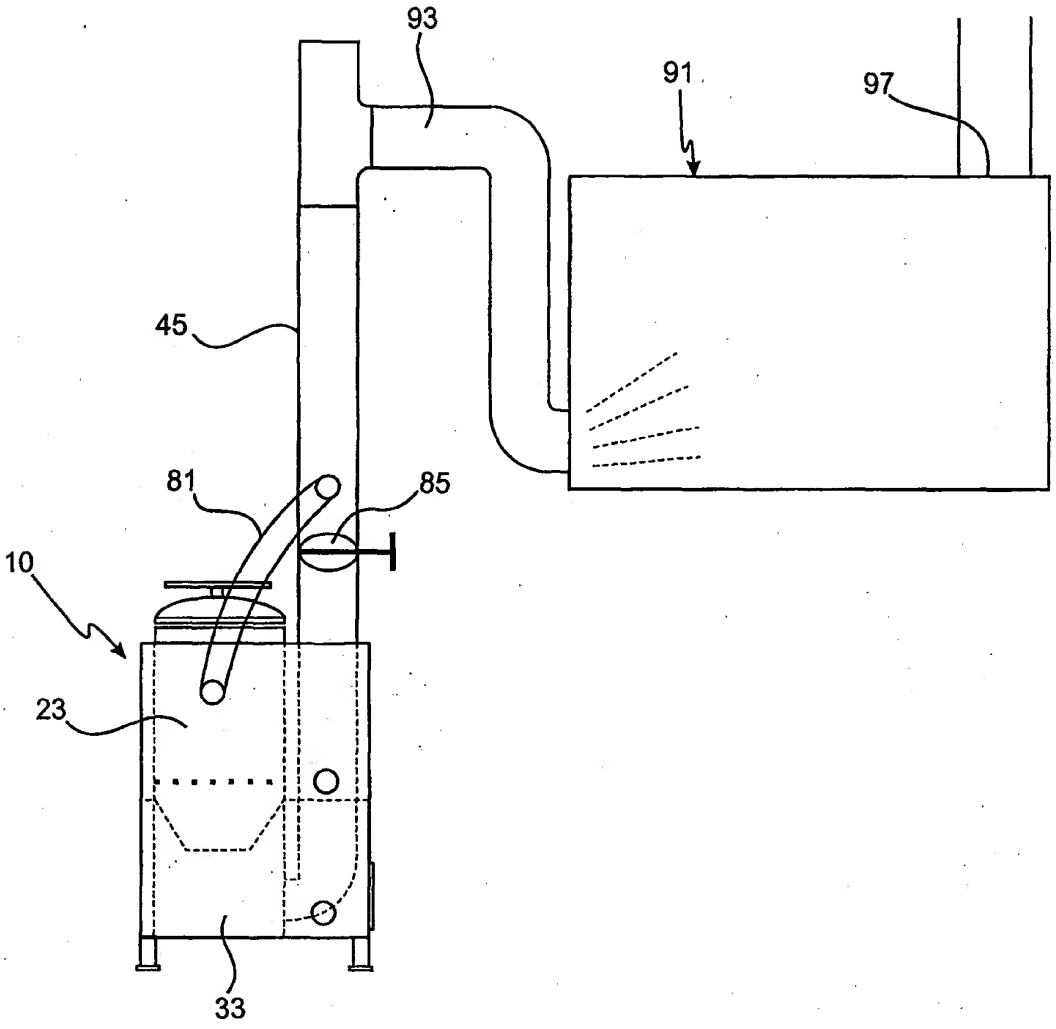

Fig. 3.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU01/00481

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: F23G 5/027, 5/24, 5/38, 5/44; F23K 1/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[7] AS ABOVE

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NIL

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI: IPC As Above with key words: Primary, Secondary

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	AU 80319/82 (550050), (Cremasco D.P.), 11 November 1982 Page 2, lines 1- 15; page 3, lines 3- 19; page 4, lines 1- 32; page 5, line 16- page 6, line 3; claim 1; figure 1	1- 27
Y	US 3961587 (Ozawa), 8 June 1976 Column 1, lines 17- 20; column 1, line 57- column 2, line 13; column, 2 lines 25- 31; column 5, lines 23- 35; claim 1	1- 27
Y	Derwent Abstract Accession No.99-235126, Class Q73, JP 11063445 A (Suzuki I I), 5 March 1999 Abstract	1- 27

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 May 2001	14 June 2001
Name and mailing address of the ISA/AU	Authorized officer
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Derwent Abstract Accession No. 98-350980 Class Q73, JP 10132246 A (Sanko Y G), 22 May 1998 Abstract	1-27
P, Y	Derwent Abstract Accession No. 2000-653072, Class Q73, JP 2000274626 A (Kyokuo KK), 3 October 2000 Abstract	1-27

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU01/00481

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
US	3961587	JP	50098169
AU	80319/82	NONE	

END OF ANNEX